



Annual Systems Engineering Research Center Research Review

15 October 2009

**The Honorable Zachary J. Lemnios
Director, Defense Research and Engineering**

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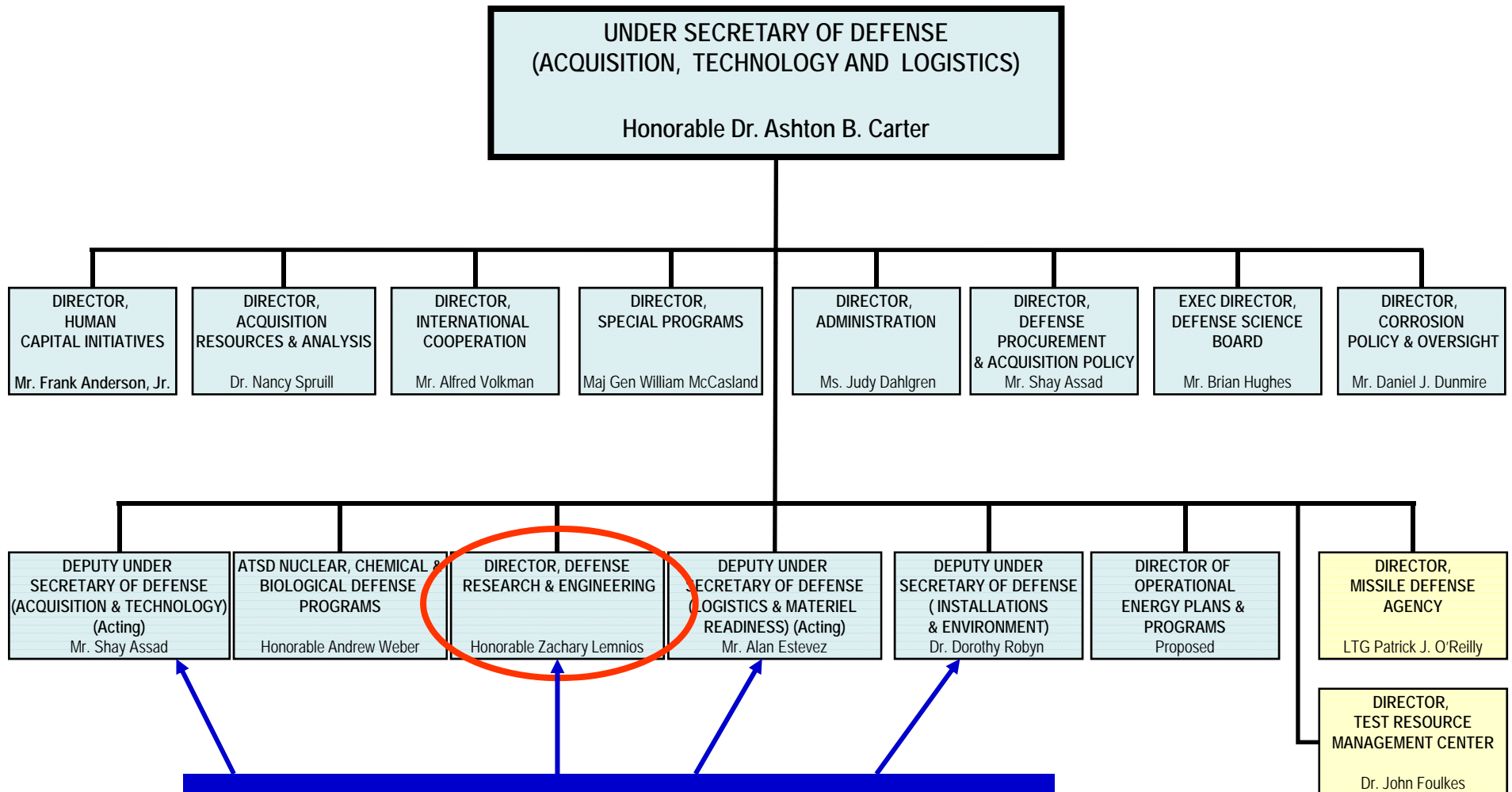


Our Guidance

- **Defense Budget Recommendation Statement**
Secretary of Defense Robert M. Gates, April 06, 2009
 - *reaffirm our commitment to take care of the all-volunteer force*
 - *rebalance this Department's programs*
 - *institutionalize and enhance our capabilities to fight the wars we are in today and the scenarios we are most likely to face in the years ahead*
 - *provide a hedge against other risks and contingencies*
 - *fundamental overhaul of our approach to procurement, acquisition, and contracting*
- **Economic Club of Chicago**
Secretary of Defense Robert M. Gates, July 16, 2009
 - *What is needed is a portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict*



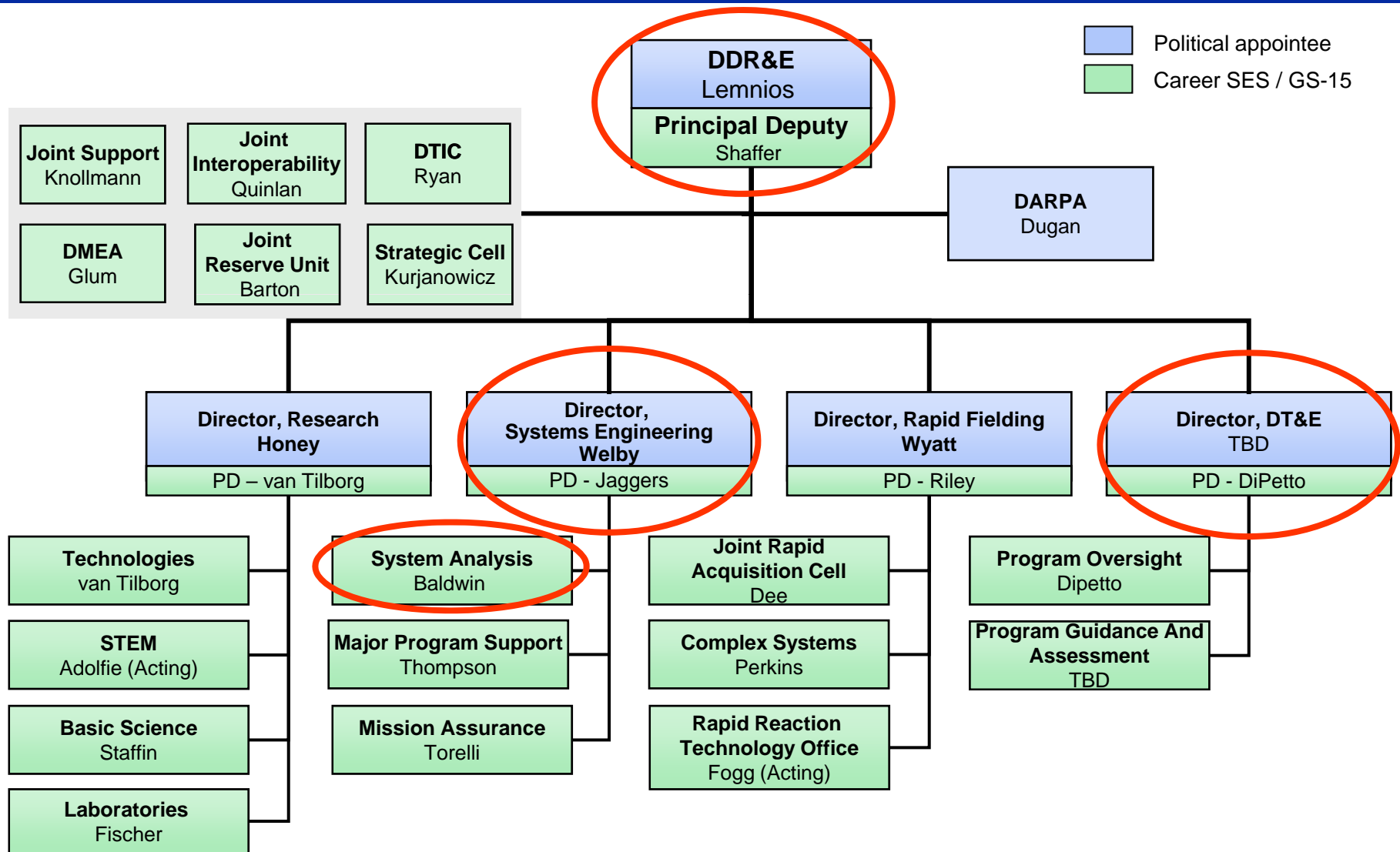
AT&L Organization



4 Deputy Under Secretary positions



DDR&E Organization





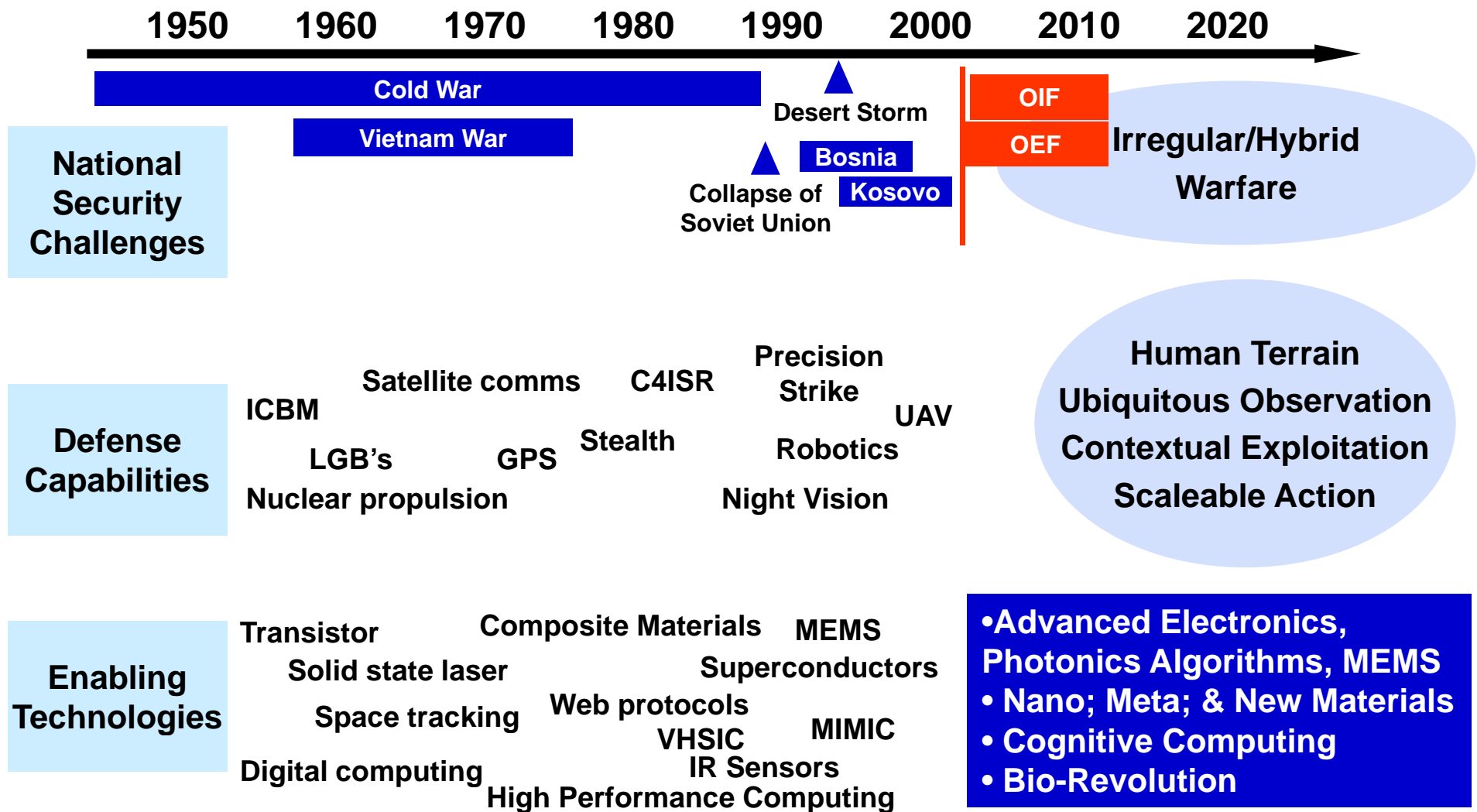
DDR&E Imperatives



- 1. Accelerate delivery of technical capabilities to win the current fight.**
- 2. Prepare for an uncertain future.**
- 3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.**
- 4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.**



Perspective for the Next Decade





Forces of Change... Irregular and Hybrid Warfare



*Operations in
Austere
Locations*

**Defense S&T for
Persistent /
Irregular Warfare**

*Humanitarian
Assistance /
Provincial
Reconstruction
Teams*

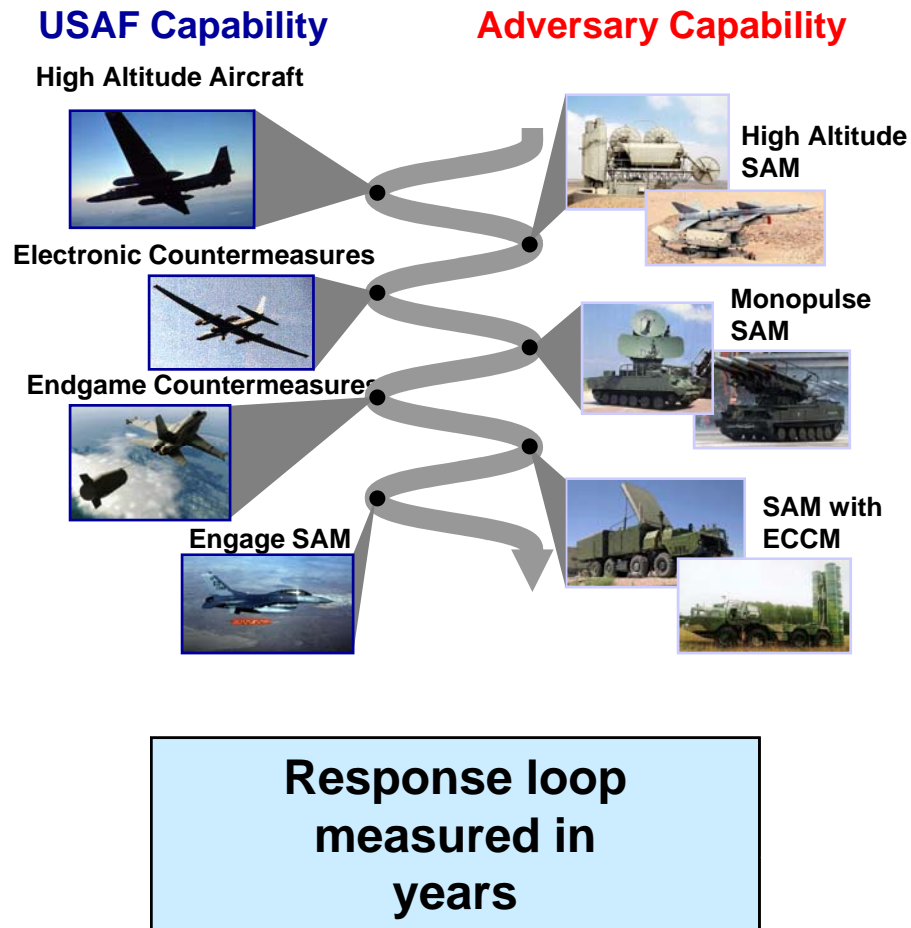
**NEW TECHNOLOGY NEEDED
*Affecting the Hearts and Minds...***



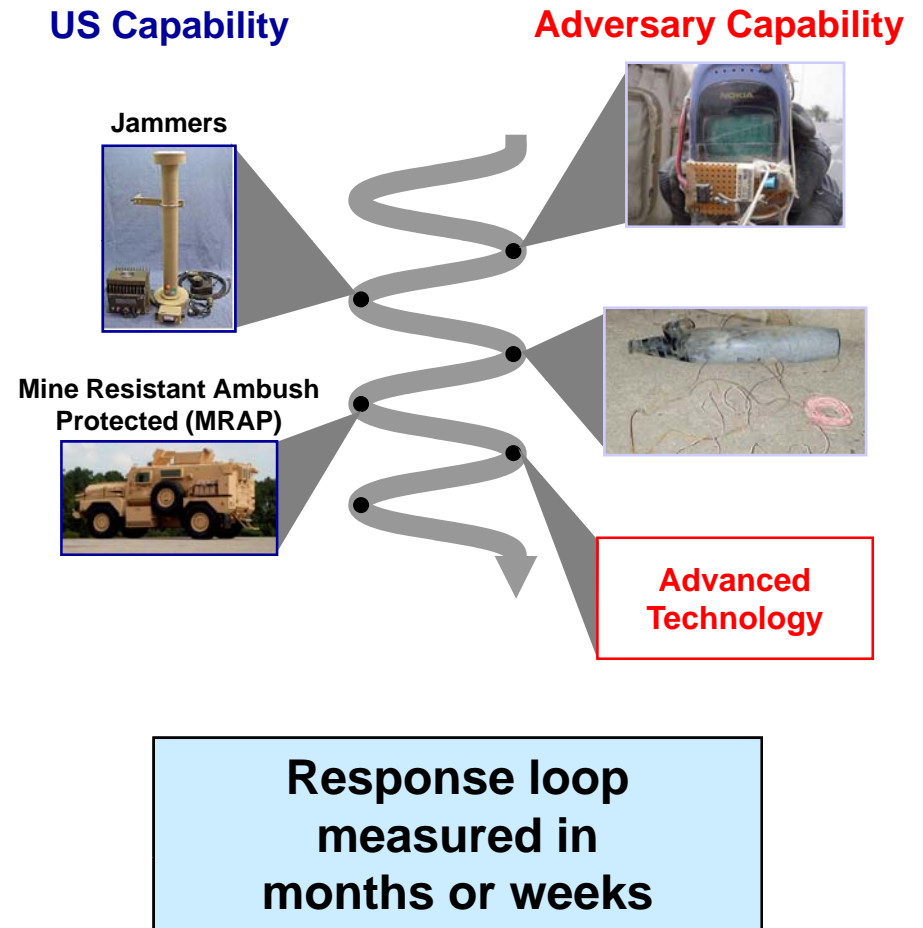
The Timeline has Collapsed!



Conventional Warfare

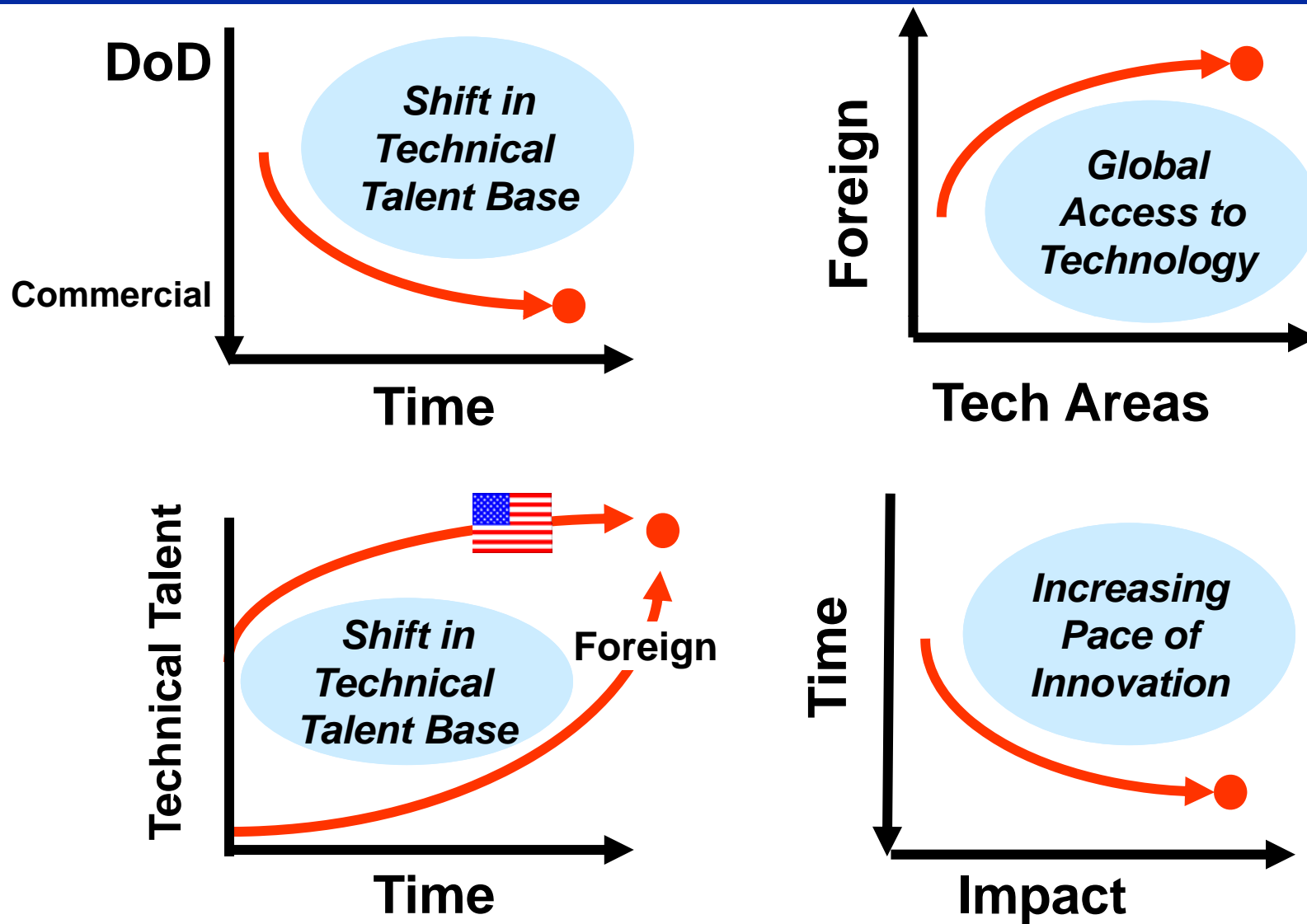


Counter-Insurgency Warfare



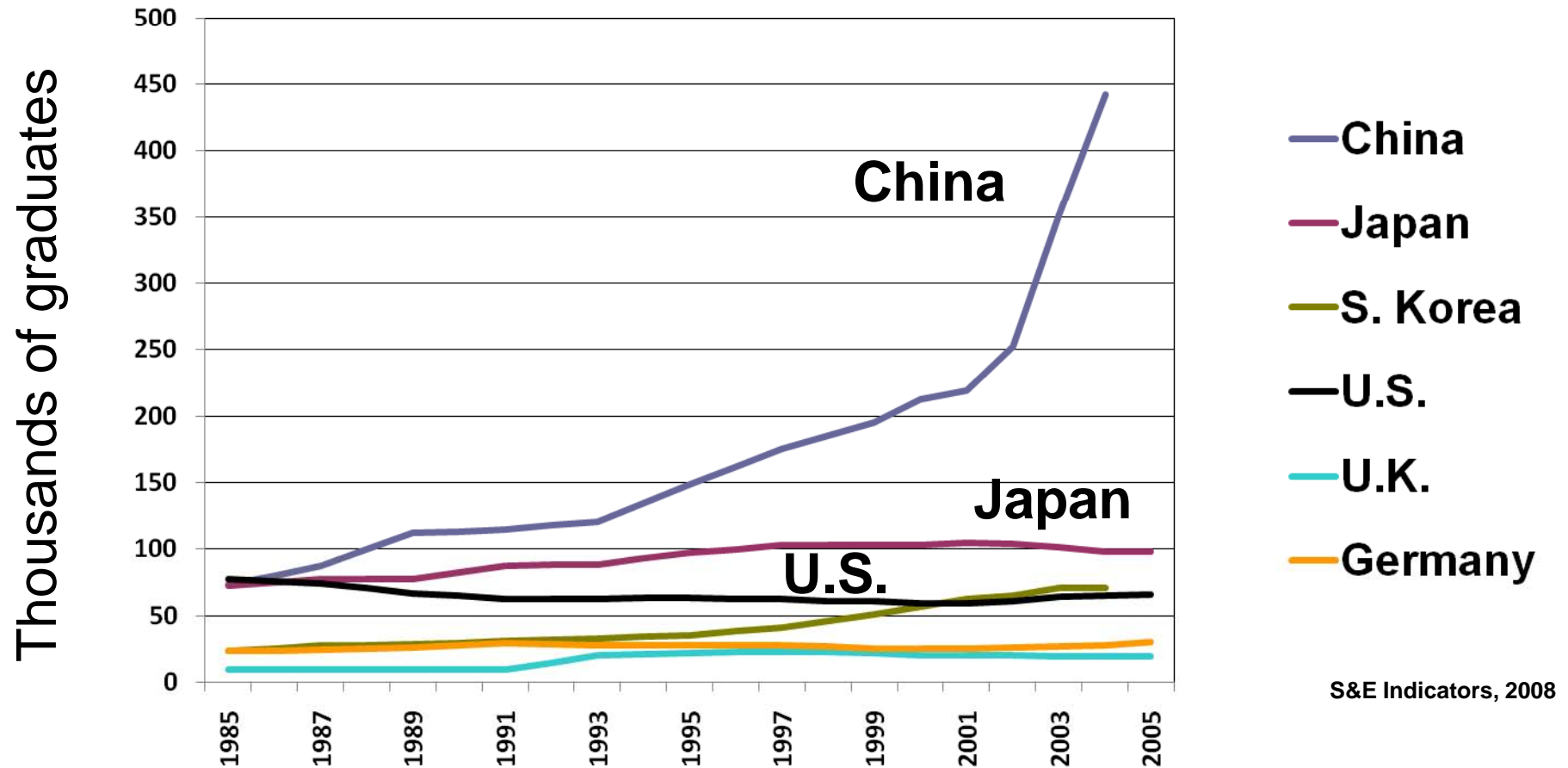


Four Key Challenges to our Technical Base





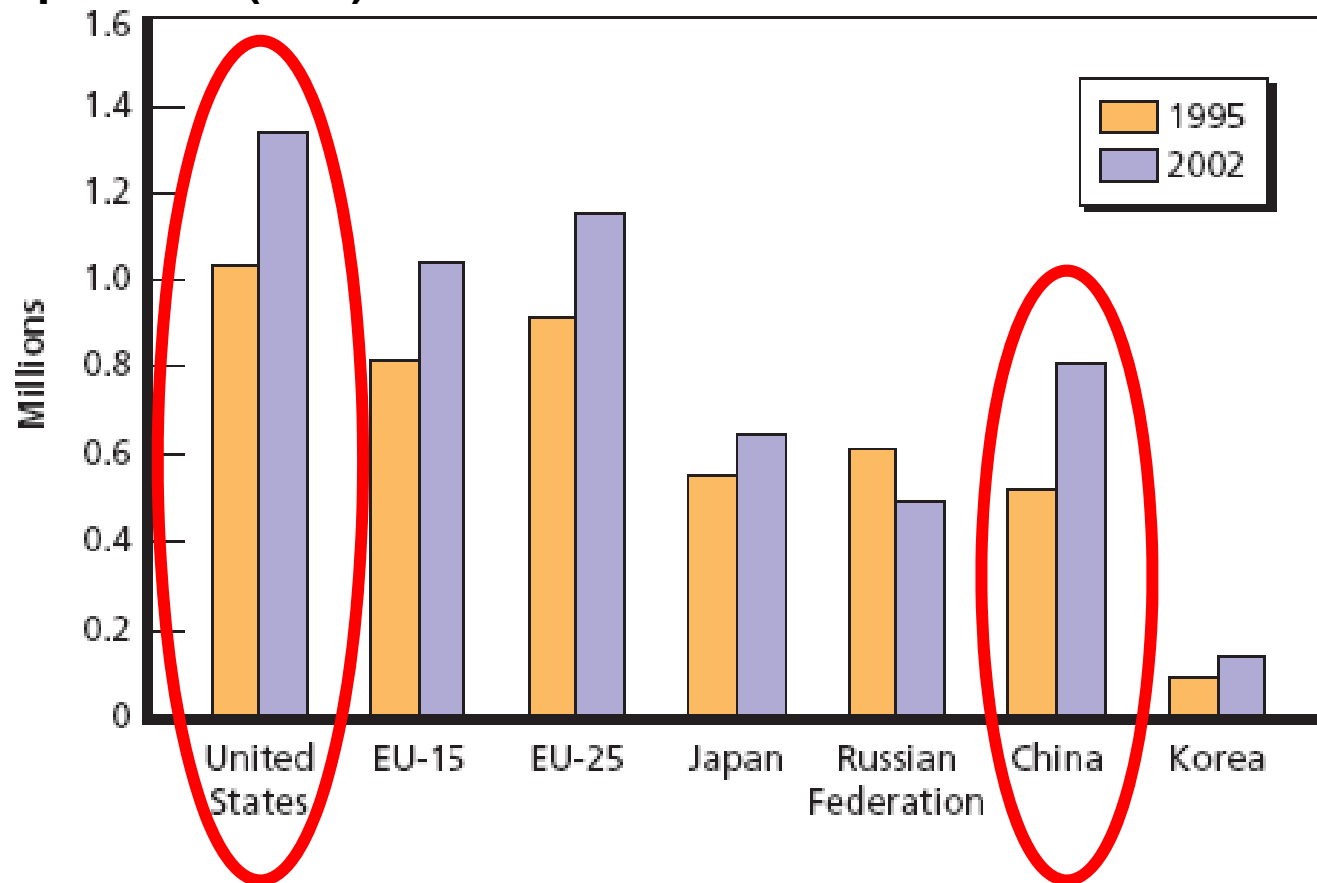
We are in a competition for the best technical talent





The Shifting Research Base

Full-Time Equivalent (FTE) Researchers



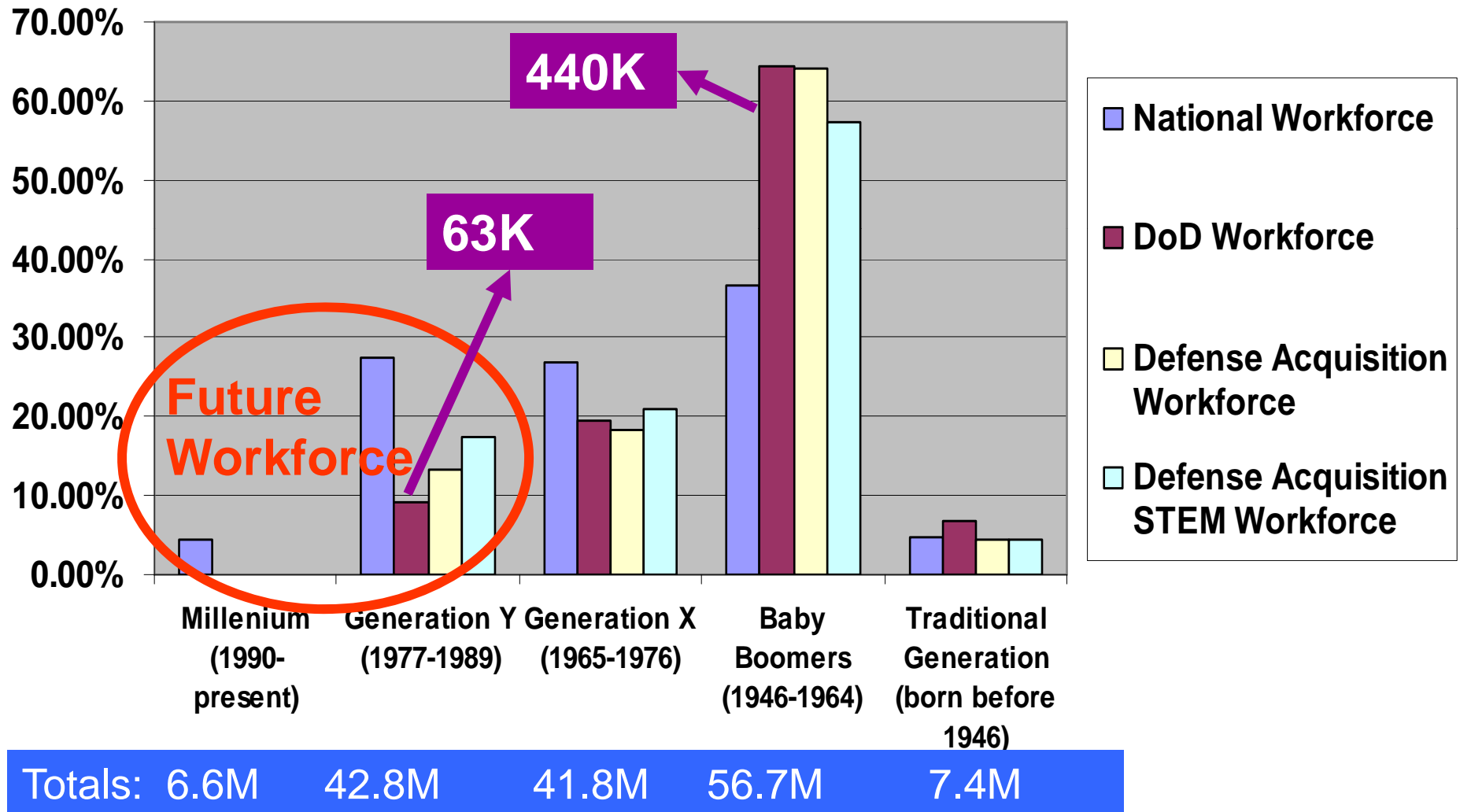
3.7%
Growth / Year

6.5%
Growth / Year

Source: OECD Science, Technology and Industry Outlook (2006)



Workforce Breakdown by Generation





The Big Three



Innovation

Speed

Agility



Comments from COCOMs



“We need to detect IED’s at range... I am willing to test technologies in the field... We need persistent communications on the move...”

“I need the 70% solution today, rather than the 100% solution in 5-8 years...”

“...we are concerned about our technological edge against a near peer competitor...”

“It took us 10 years to get to the Moon, we are 8 years into our research efforts for defeating IED's...we need to find a solution to reliably detect and defeat IED's at range...”

“I like the 1 year acquisition cycle rather than the standard 5-8 year cycle, get the prototypes into the hands of the warfighters, turn the feedback into a quick redesign and deliver relevant capability now...”

“Often times we fail due to shortage of imagination...”

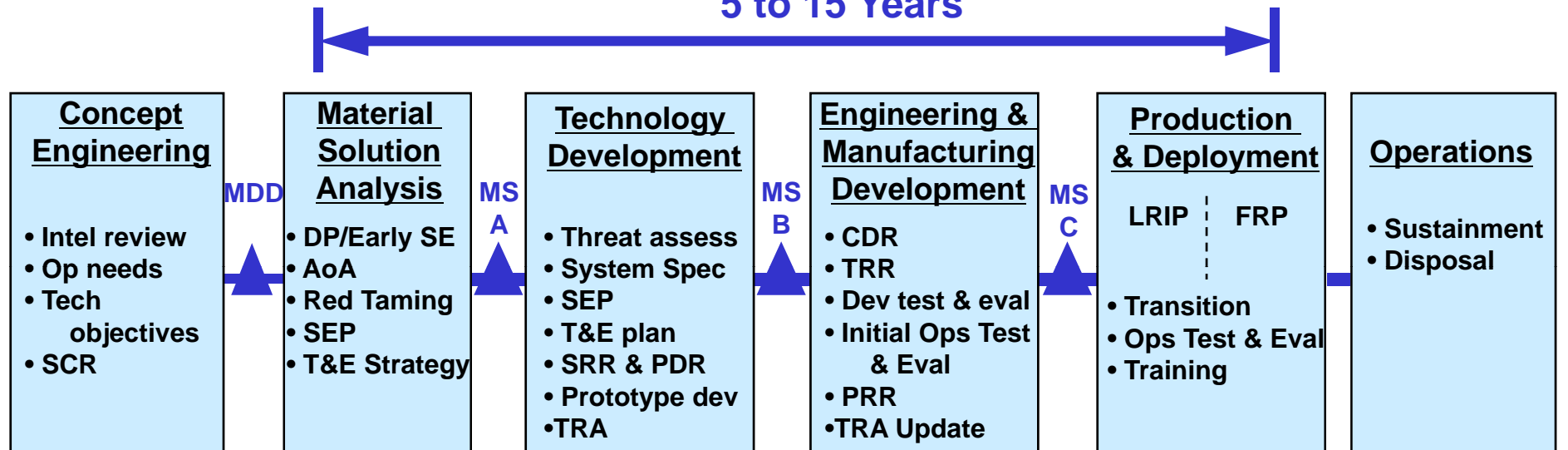


Defense Acquisition Approach

Systems Engineering is key discipline



5 to 15 Years



Technology and Risk Reduction

- Technology “push” investment
- Technology maturation
- Phenomenology measurements

70-75% of Cost Decisions Made Prior to Milestone A
Impact 72% of Total Life Cycle Costs

AoA – Assessment of Alternatives
DP – Developmental Planning
MDD – Material Development Decision
SCR – System Concept Review
SRR – System Requirements Review
SEP – System Engineering Plan
PDR – Preliminary Design Review
CDR – Critical Design Review
TRR – Test Readiness Review
PRR – Production Readiness Review
LRIP – Low-Rate Initial Production
FRP – Full Rate Production



Scope of DDR&E Acquisition Program Oversight Efforts*



Program Category	Increasing cost/risk	SE	DT&E	TMA
ACAT ID**	\$\$\$ MDA = AT&L	93	93	70
ACAT IC**	\$\$\$ MDA = CAE	29	29	52
Special Interest**	Any \$\$s Risk	17	17	19
MAIS, ACAT IA	\$-\$\$\$\$, AIS	15	15	30
Pre-MDAP	\$\$\$ pre-MS B	44	44	53
Pre-MAIS	\$-\$\$\$\$, AIS pre-MS B	9	9	10
ACAT II	\$\$ < ACAT I	0	8	0
ACAT III	\$ < ACAT II	0	3	0
Total		207	218	234

DABs in next 90 days

- BAMS IPR
- MUOS DAE Review
- FCS Follow-on
- EA-18G FRP
- JTRS MIDS MS C
- WIN-T Increment II MS-C
- SSN 774 Virginia Class MS III
- Global Hawk IPR
- HC/MC-130 MS C
- SBIRS DAE Review
- JTRS HMS MS C
- JHSV (pre-MDAP)
- JSF (F-35) LRIP

*Based on 2009 T&E Oversight List (Jan 5, 2009)

**Major Defense Acquisition Program (MDAP)

+Major Automated Information System (MAIS)

MDA – Milestone Decision Authority

TMA – Technology Maturity Assessment

CAE – Component Acquisition Executive



The Current SE Environment

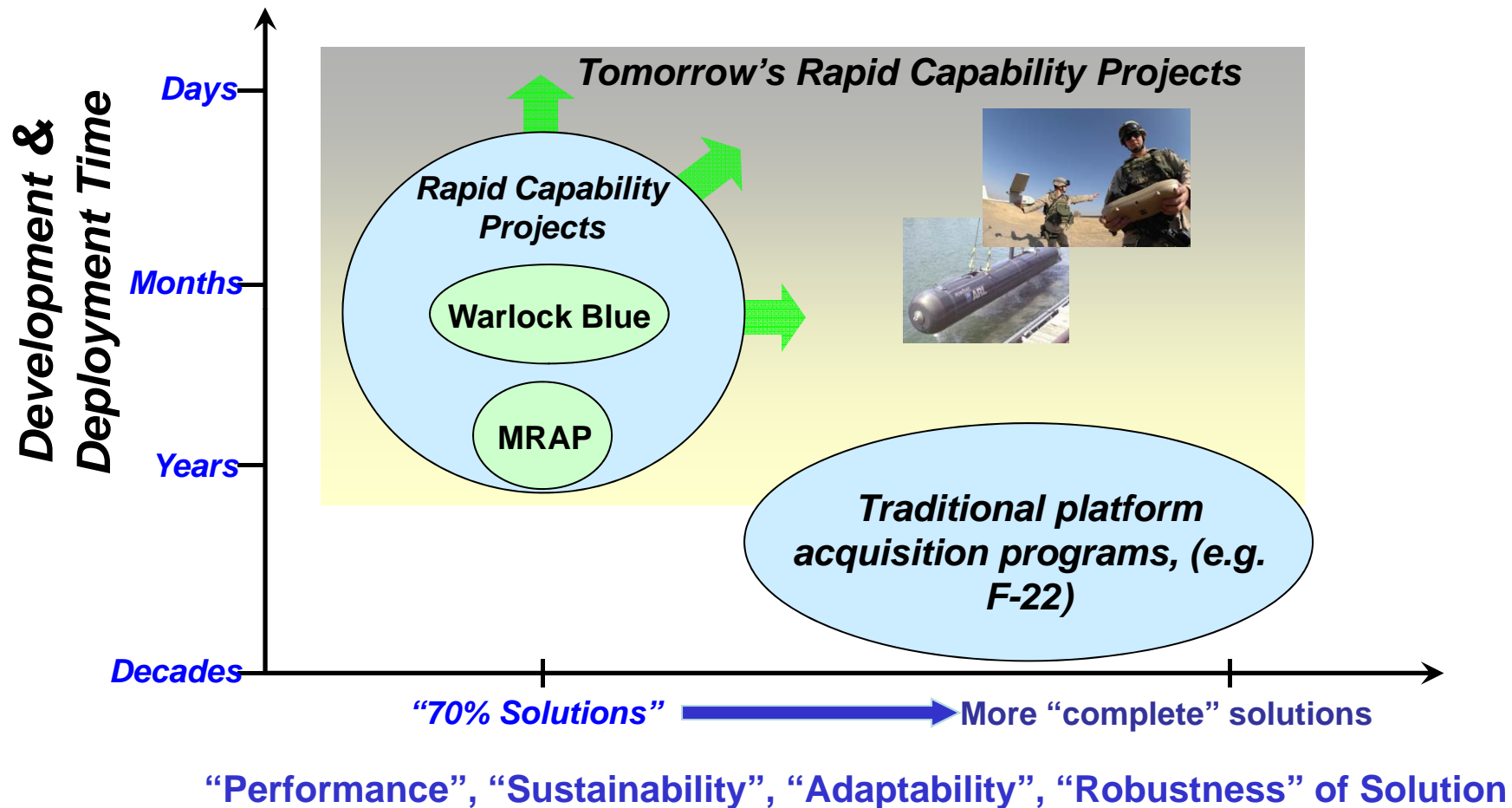


Systems Engineers confront a spectrum of issues that challenge “traditional” systems engineering

- **Complexity**
 - **Scope & Scale:** number and diversity of elements
 - **Connectivity:** interdependencies among the disparate elements
 - **Emergent behaviors:** nonlinear stochastic response functions
 - **Effects of non-technical attributes and characteristics**
- **Criticality**
 - **Systems to be continuously available**
 - **Able to deal with Security, Privacy, Authenticity, Accuracy, requirements “seamlessly” & without performance degradation**
- **Compatibility**
 - **Integrate the newest/fastest with the oldest/slowest**
- **Chronology**
 - **“Idea” to “IOC” measured in weeks/months versus years/decades**
- **Competency**
 - **Can the workforce develop the knowledge and abilities to adapt & survive?**



Rapid Capability “Toolbox”



DDR&E Rapid Capabilities Toolbox study will identify tools to enable more rapid, adaptive, robust, and sustainable solutions to the warfighter



A New Generation of Concept Engineering Tools

Warfighter Needs



Anticipatory Opportunities

Accelerated Concept Engineering Environment



Iterative Virtual and Real Prototyping

- Conceptual Designs
- CONOPs
- TTPs
- Detailed Design Models

- Immersive Virtual Environments
- Rapid Virtual Environment generation
- Virtual Environment to CAD tool translation
- Rapid Prototyping fabrication tools
- “Human-Centered Design” principles and tools
- Integrated engineering and virtual M&S

Immerse Users/Developers in a Rapidly-Configured Environment with Real and Virtual Prototypes: *Accelerated Concept Engineering*



How the SERC Adds Value



- Brings focus and synergy across the broad technical / engineering community to address complex challenges
- Develops engineering methods, tools to reduce risk in acquisition
- Inspires and advances a national competency for Systems Engineering
- Provide direct supports the DoD and Intelligence Communities
 - To do this effectively, SE Research must be *Engaged*
—this is a “Contact Sport”



Summary: Challenges Ahead



- **Create the tools to enable Rapid Capability Delivery**
 - Shorten the time to deliver life-saving and war-winning technologies – without compromising SE integrity
- **Evolve SE to design systems for adaptability**
 - Capture agility, adaptability, responsiveness as design attributes
- **Expand the aperture of SE to address 21st century technical challenges**
 - Security, software-intensive, etc...
- **Embrace complexity**
 - Systems of Systems / Complex Adaptive Systems / Emergent behaviors
- **Expand the SE human capital resource base**
 - Reflect new insights in the curriculum to grow the next “crop” of SE